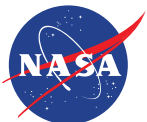# Complexity-Based Link Assignment for NASA's Deep Space Network for Follow-the-Sun Operations

Jet Propulsion Laboratory
California Institute of Technology

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SpaceOps 2018 — Marseilles, France
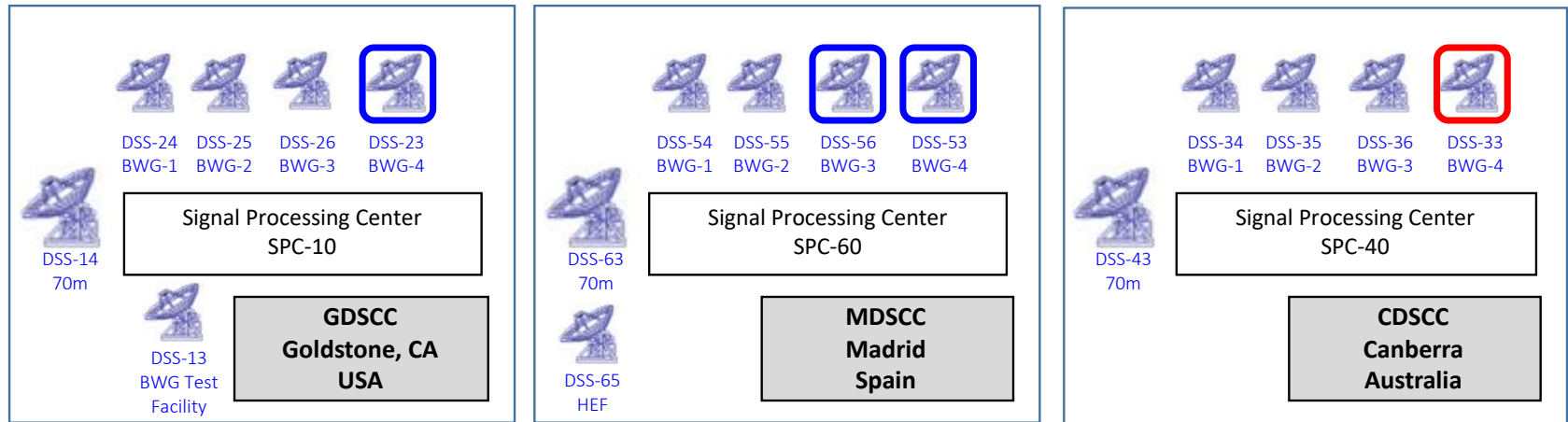
Overview

- Deep Space Network (DSN)
- Follow-the-Sun Operations – Paradigm Shift
- Role of Complexity-Based Link Assignment
  - architecture
  - interfaces
  - functionality
- Deployment and Status
- Conclusions

Deep Space Network (DSN)

- Network of 34- and 70-meter antennas in California, Madrid, and Canberra
  - All deep space missions use DSN for communications and navigation
- DSN is currently oversubscribed
  - 35 missions / science users dependent on DSN services
  - Limited network assets
  - Multi-use equipment (antenna testing / maintenance, calibration, science users)
- Small satellites represent new customer base for network

Deep Space Network Complexes and Antennas

DSS-24 BWG-1 DSS-25 BWG-2 DSS-26 BWG-3 DSS-23 BWG-4

Signal Processing Center
SPC-10

DSS-14 70m

DSS-13 BWG Test Facility

**GDSCC
Goldstone, CA
USA**

DSS-54 BWG-1 DSS-55 BWG-2 DSS-56 BWG-3 DSS-53 BWG-4

Signal Processing Center
SPC-60

DSS-63 70m

DSS-65 HEF

**MDSCC
Madrid
Spain**

DSS-34 BWG-1 DSS-35 BWG-2 DSS-36 BWG-3 DSS-33 BWG-4

Signal Processing Center
SPC-40

DSS-43 70m

**CDSCC
Canberra
Australia**

New Antennas Not Completed Yet

80-kW BWG   20-kW BWG

Goldstone, USA

Madrid, Spain

Network Operations
Control Center
JPL, Pasadena

Canberra, Australia

Why complexity-based link assignment?

- Prior to Follow-the-Sun Operations (FtSO), each complex controlled 24x7 only their own 4 or 5 antennas

Why complexity-based link assignment?

- After the FtSO transition, each complex controls the **entire** network during their shift — making work assignments more challenging!
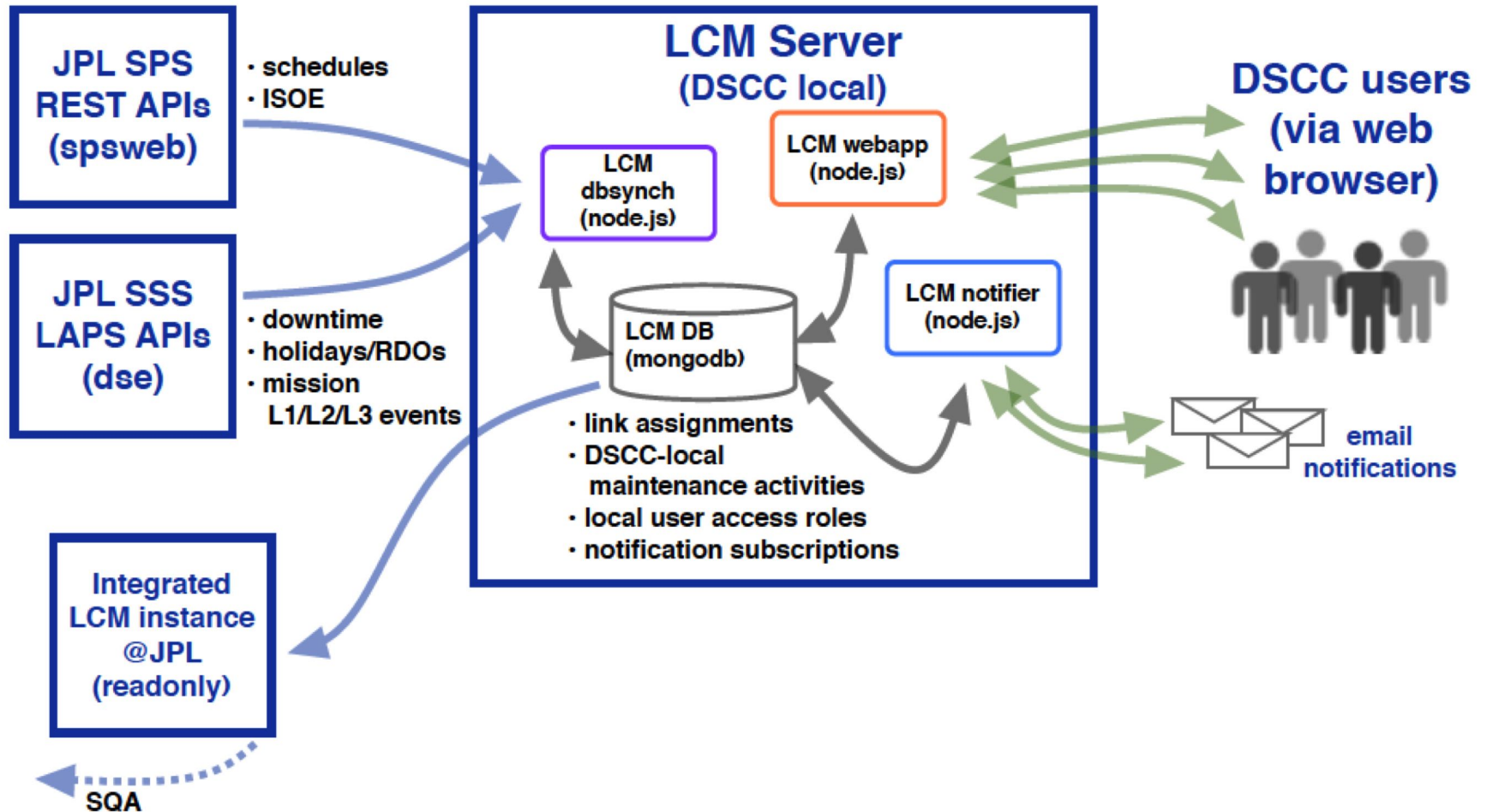
Solution

- **Decision support software for Link Control Operators (LCOs) at the DSN complexes to manage workload and breaks**
  - **LCM = Link Complexity and Maintenance Software**

Primary objective: assign links to operators automatically or interactively, considering:	‣ complexity profile of activity during link, from setup through end of teardown ‣ limits on number of links per operator and on maximum complexity per operator ‣ special rules for high intensity link phases such as 3- and 4-MSPA links, and MMS1/2/3/4 spacecraft transitions

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Secondary objective: support scheduling of site-local maintenance activities within allocated DSN maintenance windows	

LCM Context

Schedule Displays
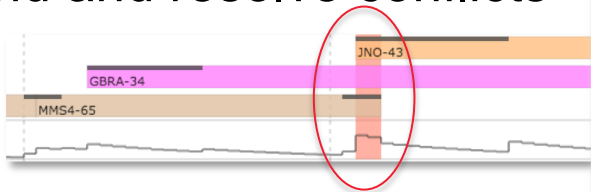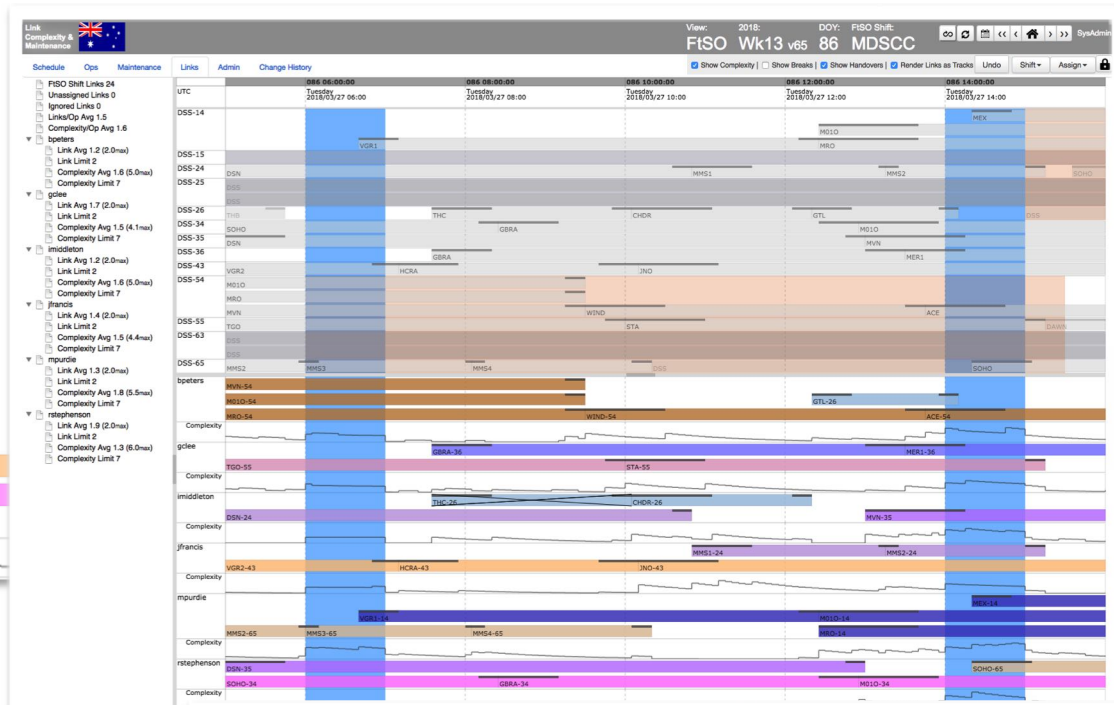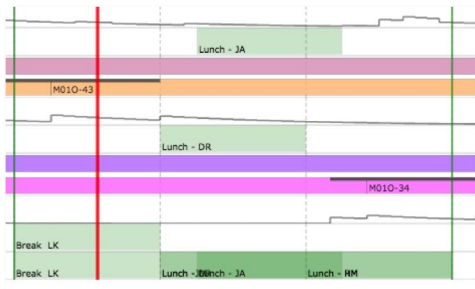
Link Assignment and Assist Dialog
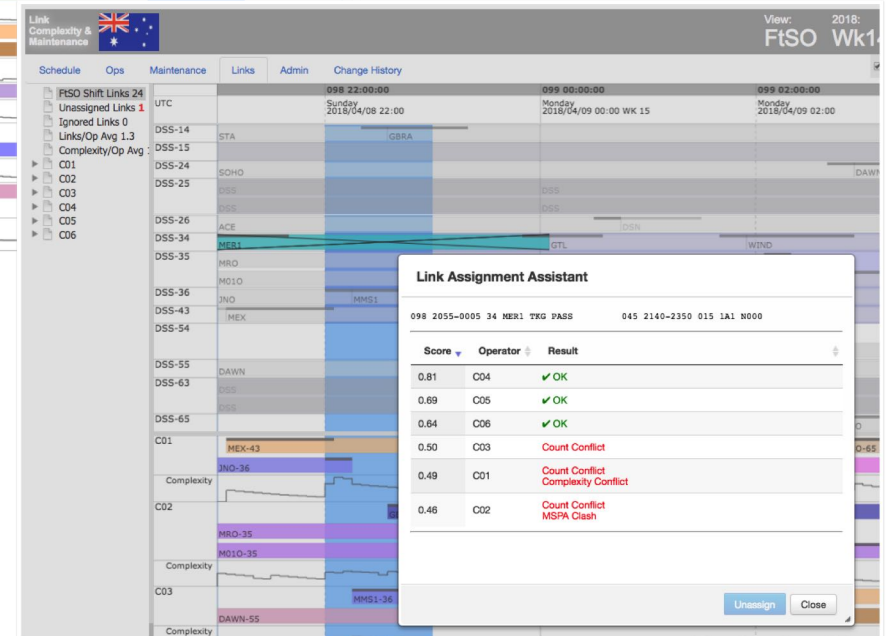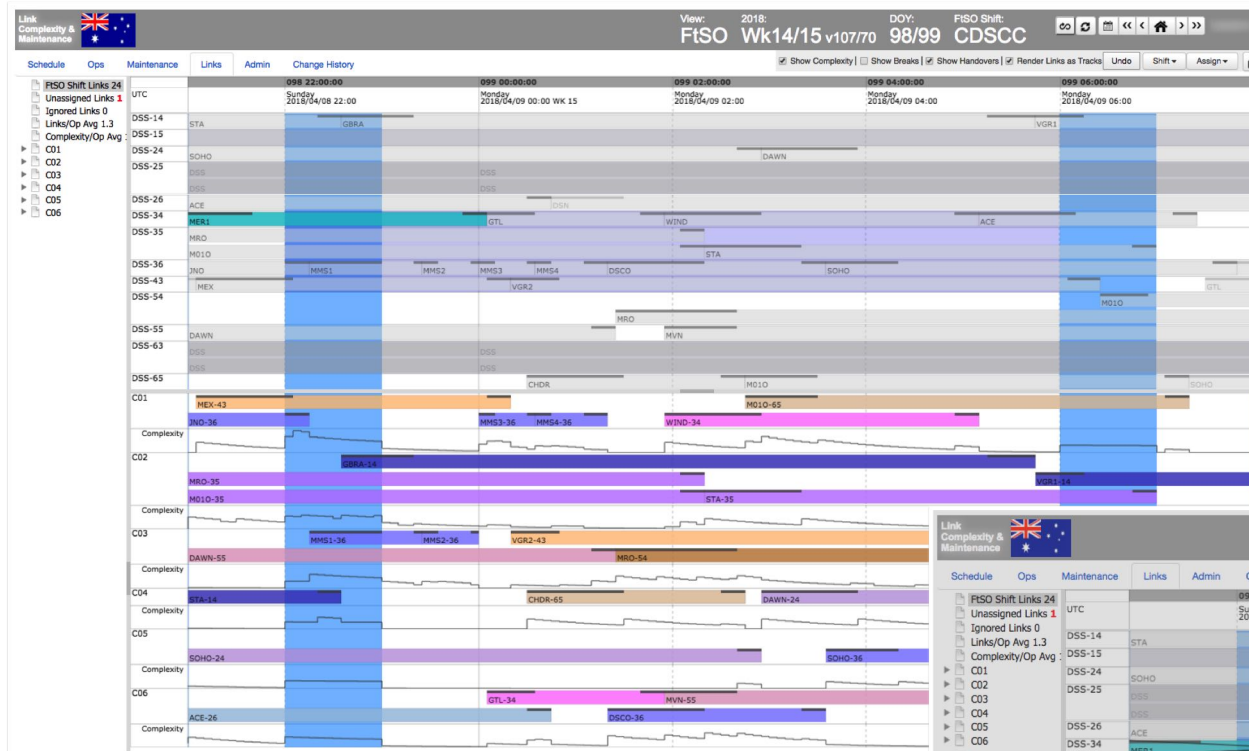
Features

- Assign links to operators
- Model complexity profiles
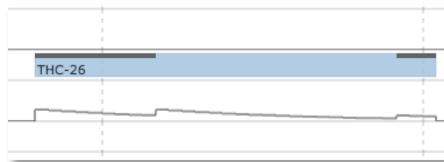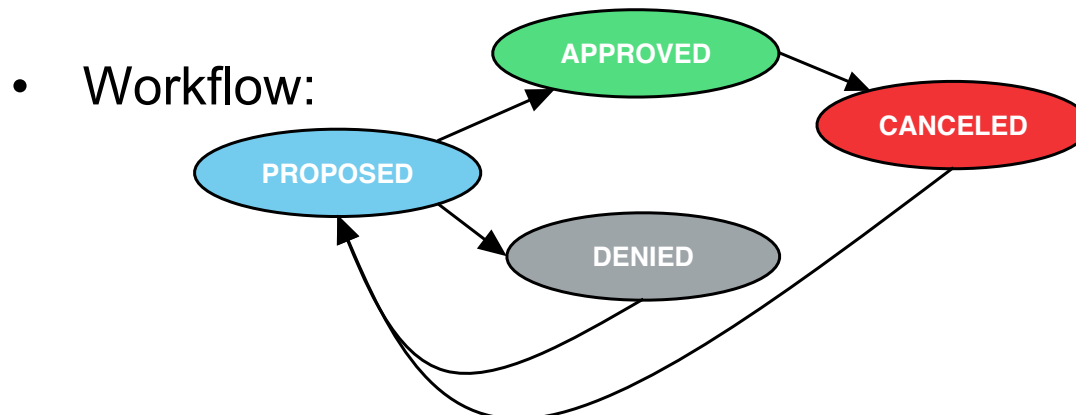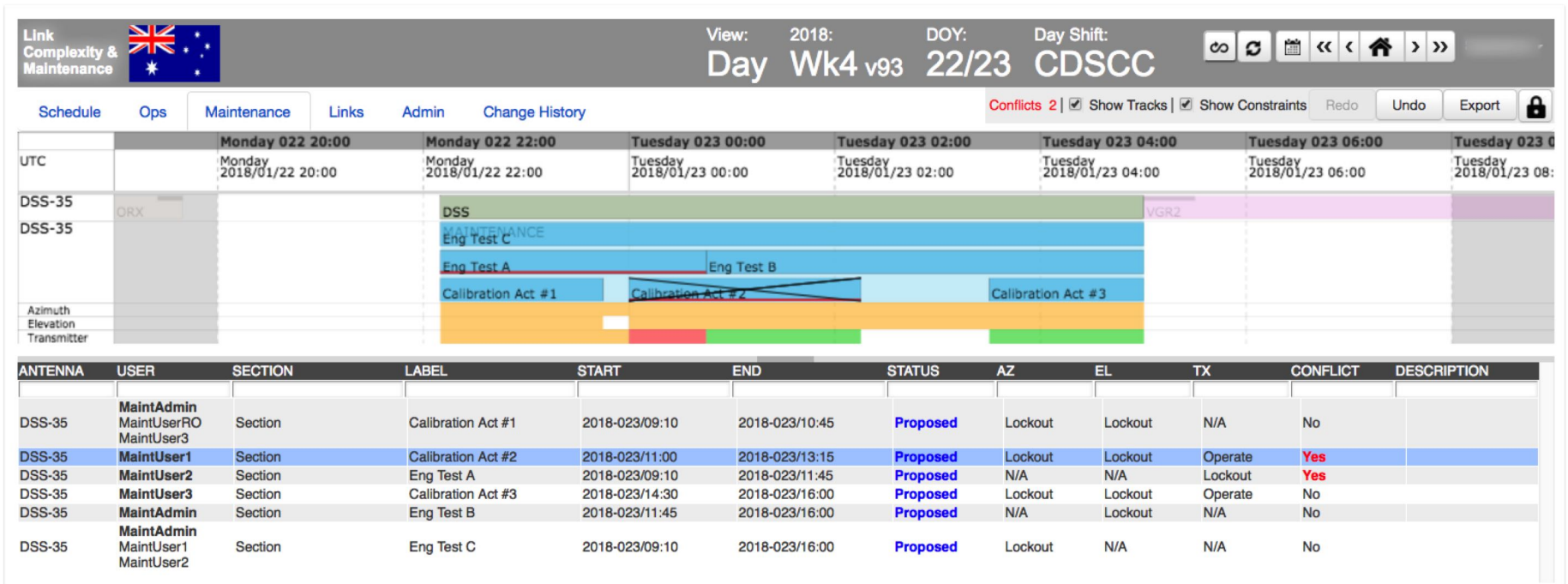

- Find and resolve conflicts

- Support break planning

Maintenance Planning

- Workflow:

Status

Supervisor Station

Deployed and operational at all 3 DSCCs prior to FtSO transition – Nov 2017

Link Control Operator